

# On the specific status of the Sangihe White-eye *Zosterops nehrkorni*, and the taxonomy of the Black-crowned White-eye *Z. atrifrons* complex

P. C. RASMUSSEN, J. C. WARDILL, F. R. LAMBERT and J. RILEY

Field observations of the very rare white-eye *Zosterops* of Sangihe Island, northern Indonesia, indicated that a reanalysis of its taxonomic status was necessary. Accordingly, an analysis of morphology and vocalizations of the Black-crowned White-eye *Zosterops atrifrons* (sensu lato) was undertaken, which confirmed that the polytypy of this group far exceeds that of a single biological species. The taxon from Seram is highly distinctive both in morphology and song, and clearly requires treatment as a separate species, the Seram White-eye *Zosterops stalker*i. The form from Sangihe differs in numerous respects from all other taxa, most obviously and significantly in its bright pinkish bill and legs, and it evidently differs in ecology and vocalizations as well. It also should be treated as a distinct species, the Sangihe White-eye *Zosterops nehrkorni*, and requires immediate listing in the threat category of Critically Endangered. All records of this species are reviewed herein. In the Sulawesi sub-region, the race *surda* of central Sulawesi is clearly a good subspecies, most similar to the nominate of northern Sulawesi; the taxa of the Sula Islands (*sulaensis*) and of Peleng Island (*subatrifrons*) form another group, to which an undescribed subspecies of south-central Sulawesi also apparently belongs. The song of *sulaensis* is distinctly different than for the *atrifrons* group, and species status is probably warranted for the group that includes *sulaensis*, in which case *subatrifrons* would be the name with priority; however, further study is needed. The group of races from the New Guinean region is highly polytypic, but consistently different from the aforementioned races, and pending further study, should be treated (as some authors have recently done) as the Black-fronted White-eye *Zosterops minor*.

## INTRODUCTION

Extensive recent avifaunal surveys of the island groups of Sangihe and Talaud (North Sulawesi Province, Indonesia) have resulted in the discovery or rediscovery of several endemic taxa, and much improved knowledge of nearly all the known avian species of these previously ornithologically neglected islands. A notable exception remains the exceedingly rare white-eye of Sangihe, *Zosterops nehrkorni* Blasius, 1888 (Plate 1). Unlike most members of its genus, which tend to be among the more common and conspicuous of small forest birds, this enigmatic bird seems always to have been rare, eluding all of the early explorers of Sangihe. The first, and for many years the only, indication of its existence was when the type specimen was collected in late 1886 by Dr and Mrs Platen, whose contributions to the ornithology of the Philippines and Indonesia made the museum in Braunschweig (now SNMB) a centre of Asian descriptive ornithology around that time. The Sangihe *Zosterops* was immediately recognized as a new species, and was among those taxa which Blasius controversially described to science in a local Braunschweig newspaper (Blasius 1888a), a mode of publication apparently prompted by prior pre-emptions by British competitors (Dickinson and Heucke 1986).

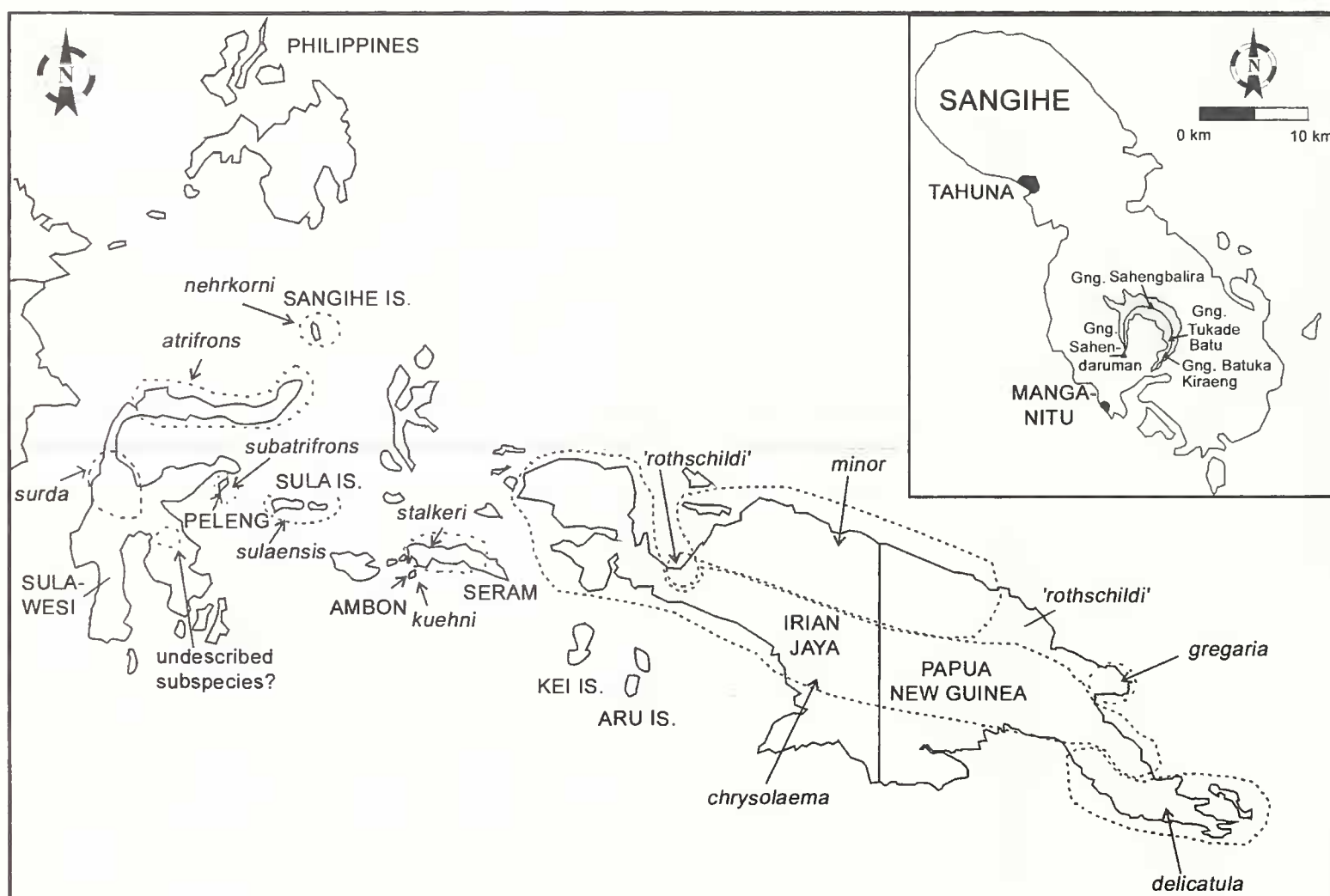
At the time of the description of *nehrkorni*, clearly distinguishable new taxa were normally treated as species. With the general acceptance of the trinomial and the *Formenkreise* (which allowed for extremely polytypic species provided their constituents were allopatric and could be assumed to have retained the

capacity to interbreed: Stresemann 1936a), *nehrkorni* was subsumed as a race of Black-crowned White-eye *Zosterops atrifrons* Wallace, 1864, of Sulawesi (Stresemann 1931). Other regional taxa were described after *nehrkorni*: *subatrifrons* Meyer and Wiglesworth, 1896; *stalker*i Ogilvie-Grant, 1910; *surda* Riley, 1919; and *sulaensis* Neumann, 1939; the last two were originally described as trinomials of *Z. atrifrons*. Thus, *nehrkorni* was reduced to a status of only marginal, regional interest, and for many years received little attention; indeed we have seen no evidence that its taxonomic status has been reconsidered in conjunction with re-examination of the holotype subsequent to Meyer and Wiglesworth (1898). While working on Asian Zosteropidae, G. F. Mees attempted to locate the unique specimen of *nehrkorni* through correspondence with Otto von Frisch. However, the latter could not locate it (C. Hinckelmann pers. comm.), which is unsurprising given that numerous specimens were missing from the SNMB after WWII (G. Boenigk, pers. comm., Lambert and Rasmussen 1998). For this reason, Mees (1961) listed the specimen as probably lost, and subsequently this has been repeated. Nevertheless, the type had actually been located sometime after Mees's enquiry (Hinckelmann and Heinze 1990), and it is in excellent condition. As is typically the case, published descriptions and field data are insufficient to allow confident re-evaluation of the systematic status of *nehrkorni*, and the existence and availability of specimen material (even, as in this instance, of a single individual) is essential for this purpose.

The confirmation that the Sangihe *Zosterops* is indeed very rare and restricted to a tiny, highly threatened patch of forest, together with field observations by JCW and FRL, which made it clear that it appears strikingly different in life from *Z. a. atrifrons* of North Sulawesi, and an unexpected encounter by PCR with the type specimen, which had been recently stated to be missing (Wardill and Hunowu 1998), led us jointly to re-evaluate its taxonomic status. However, the current placement of *nehrkorni* within a polytypic species of variable composition meant that it was necessary for us to reconsider all the taxa that Mees (1961) had proposed as conspecific with *atrifrons*; additional Papuan island taxa considered as races of *atrifrons* by Mayr (1967) are more distinct and, although they were examined, are not dealt with further here.

All members of the large genus of white-eyes, *Zosterops*, possess simple plumage patterns, although rearranged in seemingly infinite combinations, from Africa through the western Pacific. Thus geographically disparate (and presumably non-sister) taxa may look much alike, while neighbouring taxa that might be expected to be closely related often show very different plumage patterns. Most species of *Zosterops* are structurally very similar, further complicating reconstruction of relationships based on external morphology. No character common to various taxa of *Zosterops atrifrons*, a heterogeneous assemblage (Plate

1) united by Mees (1961), is unique to or diagnostic of this group. The most consistent feature, the black forehead, is lacking on one putative member, while it is present on other taxa treated as specifically distinct elsewhere in Indonesia and on some Papuan islands (Mees 1961). In alternative treatments, *Zosterops atrifrons* is considered to consist only of taxa from Sulawesi through Seram (Sibley and Monroe 1990, Howard and Moore 1991), in which case the New Guinea taxa are grouped together as the Black-fronted White-eye *Zosterops minor*, or to include additional insular taxa of the Papuan region (Mayr 1965 and 1967). Mayr (1965: 1) aptly summed up the incongruities of the treatment that both he and Mees (1961) espoused thus: "I know of no other group of birds in which close relatives, for example the subspecies of *Zosterops atrifrons* ... may differ more from each other than do distantly related species." Mayr also stated (*loc. cit.*) "Absolute criteria of relationship in the Zosteropidae do not exist at the present time..." and "White-eyes have characteristic songs and call notes, and perhaps analysis of these and other behavioral characters may lead to a better understanding of relationships." In this paper, we re-examine the taxonomy of the *Zosterops atrifrons* group using external morphological characters and vocalizations, and review the little that is known of the history and status of the white-eye of Sangihe.



**Figure 1.** Map of the distributions of taxa of the Black-crowned White-eye *Zosterops atrifrons* (s.l.) group and the Ambon White-eye *Z. kuehni*, with an inset of Sangihe in which the approximate area of remaining forest is denoted by shading. Localities at which *Z. nehrkorni* has been recorded are marked. The main map is modified from Mees (1961).



METHODS

The sole *nehrkorni* specimen was compared on two occasions by PCR directly with three *Z. a. atrifrons* from Rurukan, Minahasa Peninsula, Sulawesi, at the SNMB. One of these was an immature, and the others apparently full adults. Many photographs were taken of the type of *nehrkorni* in comparison with these other three *atrifrons*, and these have been indirectly compared with other taxa. All specimens available of other taxa of *Zosterops atrifrons* (sensu Mees 1961) at the museums listed in the Acknowledgements were examined as well. Measurements taken (solely by PCR to minimize bias) of all but the most common taxa were: culmen from skull base; upper mandible height from nares; bill width from nares; bill width at 1, 2, and 3 mm from tip; approximate extent of black crown from bill base; width of upper and lower rims of eye-ring; wing length (flattened and straightened: Svensson 1970); shortfalls of each primary from wing-point (e.g. longest primary) of folded wing, numbered ascendantly (Svensson 1970,

outermost = P1, innermost = P9); tarsus length; tarsus distal width; length of claw of the second (longest) digit and hallux; hallux length; tail length; width of fresh, undamaged central rectrix. Statistics were performed using SYSTAT 8.0. Sexes appeared similar in all taxa, but as very few confidently sexed birds were available for most taxa, they were not separated for statistical analyses.

Specimens were aged, where possible, principally by comparison of shape of the outer rectrices (narrow with acute tips in immatures vs broad with rounded tips in adults) with those of full adults of the same taxon. Immatures were included in statistical analyses except for age-related characters such as eye-ring width, extent of black on forehead, and rectrix width. PCR was unable to determine with confidence whether pre-adult plumages were juvenile or first-basic plumages, or both and, therefore, non-adult plumages are collectively referred to as ‘immatures’. In any case, there was normally little doubt as to whether a given specimen was immature or adult.

**Table 1.** Statistics (mean ± SD, *n*) for measurements of members of the Wallacean races of the *Z. atrifrons* (s.l.) complex

Variable	<i>nehrkorni</i>	<i>atrifrons</i>	<i>surda</i>	<i>subatrifrons</i>	<i>sulaensis</i>	<i>stalkerii</i>
Culmen from skull	15.9	13.3±0.6, 34	14.4±0.7, 14	14.2±0.3, 5	14.8±0.6, 9	14.1±0.5, 13
Upper mandible height at nares	2.8	2.3±0.2, 34	2.3±0.1, 14	2.3±0.1, 5	2.3±0.1, 9	2.4±0.1, 12
Bill width at nares	3.3	2.9±0.3, 34	2.9±0.2, 14	3.0±0.2, 5	3.0±0.3, 10	2.9±0.3, 13
Bill width 1 mm from tip	0.8	0.9±0.1, 29	—	0.8±0.1, 4	0.8±0.1, 9	0.8±0.1, 5
Bill width 2 mm from tip	1.0	1.1±0.1, 29	1.1±0.1, 14	1.0±0.1, 4	1.1±0.1, 9	1.1±0.1, 5
Bill width 3 mm from tip	1.3	1.4±0.1, 29	1.5±0.1, 14	1.3±0.1, 4	1.3±0.1, 9	1.4±0.1, 5
Extent of black crown (ads)	9.1	10.6±1.5, 31	11.0±1.6, 13	15.3±0.1, 2	17.0±1.4, 8	19.6±1.9, 8
Upper eye-ring width (ads)	1.3	1.5±0.2, 25	1.1±0.1, 14	1.8±0.1, 2	2.5±0.4, 8	1.3±0.2, 7
Lower eye-ring width (ads)	0.9	1.5±0.3, 25	1.1±0.2, 14	1.6±0.1, 2	2.7±0.4, 8	1.6±0.7, 7
Wing length (maximum arc)	59.0	53.3±1.2, 35	57.1±2.2, 14	54.7±2.4, 5	56.6±1.5, 10	54.3±1.5, 14
P1 shortfall	6.9	5.6±0.8, 29	6.1±1.1, 12	6.0±0.7, 4	6.3±0.9, 9	5.1±1.0, 11
P2 shortfall	3.3	1.7±0.6, 28	1.9±0.7, 12	1.7±0.2, 4	1.9±0.5, 9	1.5±0.4, 9
P3 shortfall	1.4	0.2±0.3, 27	0.4±0.6, 12	0.4±0.5, 4	0.2±0.6, 9	0.0±0.0, 10
P4 shortfall	0.0	0.1±0.3, 26	0.1±0.4, 12	0.1±0.2, 4	0.0±0.0, 9	0.2±0.6, 10
P5 shortfall	1.4	1.2±1.0, 20	1.3±0.7, 10	2.3±0.4, 4	1.2±0.6, 7	1.7±0.5, 8
P6 shortfall	3.2	3.6±1.4, 20	3.5±0.7, 9	4.4±0.4, 4	2.8±1.0, 7	3.9±0.9, 7
P7 shortfall	4.9	5.0±1.3, 18	5.1±1.1, 7	6.1±1.0, 3	4.7±1.1, 6	5.5±0.8, 8
P8 shortfall	7.0	6.4±1.7, 16	6.6±0.7, 7	7.6±1.5, 2	—	6.9±1.1, 8
P9 shortfall	7.4	8.2±1.4, 16	7.7±1.4, 6	9.9±1.8, 2	—	8.2±1.2, 8
Tarsus length	17.0	16.0±1.1, 34	17.7±1.4, 14	16.7±0.9, 4	16.4±0.5, 8	16.8±0.6, 14
Tarsus distal width	3.0	2.3±0.2, 35	2.4±0.1, 14	2.4±0.0, 5	2.5±0.1, 10	2.5±0.1, 14
Midclaw length	4.4	4.0±0.4, 35	4.2±0.4, 14	4.1±0.5, 5	4.3±0.3, 8	4.0±0.3, 13
Hallux claw length	5.8	5.1±0.2, 34	5.6±0.2, 13	4.8±0.3, 4	5.0±0.4, 6	5.3±0.3, 12
Hallux length	5.3	4.7±0.4, 29	5.1±0.4, 12	5.1±0.3, 4	5.1±0.7, 9	5.0±0.4, 10
Tail length	40.5	37.3±1.2, 35	40.3±1.5, 14	38.0±2.7, 4	39.7±1.7, 10	35.6±1.5, 9
Central rectrix width (ads)	8.4	6.7±0.5, 27	6.6±0.5, 12	5.7	6.6±0.5, 5	5.8±0.6, 11

See ‘Methods’ for explanation of the variables

**Table 2.** Qualitative external morphological character states of adults of the *Zosterops atrifrons* (s.l.) complex

Character	<i>nehrkorni</i>	<i>atrifrons</i>	<i>surda</i>	<i>subatrifrons</i>	<i>sulaensis</i>	<i>stalkeri</i>
Bill colour in skins	very pale except culmen	black	black	black	black	dark to pale horn
Lower mandible base	all very pale	black	slightly pale	pale	pale	pale
Eye-ring	rather narrow	moderate	rather narrow	rather broad	very broad	rather narrow
Extent of black crown	mid-eye	rear eye	behind rear eye	rear crown	rear crown	to nape
Crown/nape contrast	strong	little	little	moderate	moderate	weak
Auriculars	golden-olive	olive	olive	dusky olive	dusky olive	blackish
Chin	as throat	as throat	as throat	as throat	as throat	some blackish
Malar/throat contrast	moderate	none	none	strong	strong	weak
Throat colour	lemon yellow	dull yellow	very dull yellow	orange-yellow	rich orange-yellow	bronzy olive
Throat colour extent	rather extensive	moderate	moderate	moderate	moderate	very extensive
Throat/breast contrast	weak	weak	very weak	strong	strong	moderate
Mantle colour	bright olive	mid-olive	dusky olive	mid-olive	mid-olive	bronzy olive
Wing coverts	bright olive	mid-olive	dusky olive	mid-olive	mid-olive	bronzy olive
Wing edgings	broad, bright	moderate	moderate	narrow, olive	narrow, olive	narrow, pale olive
Marginal coverts	yellow-white	yellow-white	yellow-white	yellow-white	yellow	black
Rump	very bright	moderately bright	slightly bright	moderately bright	moderately bright	bronzy yellow
Breast	mid-grey	pale grey	mid-grey	very pale grey	whitish	greyish-white
Sides	mid-grey	pale grey	mid-grey	whitish	whitish	greyish-white
Thighs	yellow	grey to yellow-white	grey to yellow-white	-	yellow or white	whitish
Vent	bright yellow	mid-yellow	olive-yellow	olive-yellow	dull yellow	orange-yellow
Extent of vent colour	extensive	moderate	moderate	moderate	moderate	limited
Tarsi	very pale	dark	dark	darkish	dark	dark
Nails	very pale	dark	dark	darkish	moderate	pale
Tail	black	blackish	blackish-brown	blackish	dusky, olive edges	brownish-black

Full names of museums for which acronyms are used in the text are presented in the Acknowledgements. For clarity and simplicity we refer henceforth to *Zosterops atrifrons* (sensu Mees 1961) as *Z. atrifrons* (s.l.) (= sensu lato); when *atrifrons* is used without qualification, this denotes the nominate subspecies of the Minahasa Peninsula of northern Sulawesi.

Sonagrams were made by R. Ranft using Avisoft-SAS (Lab Pro 3.73, Berlin, Germany). A tape-recording of *nehrkorni* made by JR that was unsuitable for making a sonagram (R. Ranft pers. comm.) was studied using Gram23 software, in which the fainter notes could be visualized in colour.

### RESULTS

#### Diagnosis of immatures

The immature plumage of this group of white-eyes closely resembles the adult plumage (but to varying degrees depending on the taxon), and has therefore not

been consistently distinguished by previous authors (e.g. Mees 1961). This has contributed to an erroneous impression of high intrataxon variability in certain age-related features, especially colour of the throat, extent of black on the crown, and size of the white eye-ring. However, all of these characters have differentiated among island populations, as enumerated below. For all the taxa for which an immature plumage is known (that is, all taxa except *nehrkorni*), this stage differs in its slightly to markedly duller throat; slightly to markedly less extensive black on the crown, in which the black areas are typically somewhat mottled with olive; and its smaller white eye-ring.

#### Morphology of *nehrkorni*

##### Direct comparisons between *nehrkorni* and *atrifrons*:

The single specimen of *nehrkorni* (an adult) is larger than all specimens of nominate *atrifrons* in most dimensions (Table 1), especially bill size. The bill of *nehrkorni* is deeper throughout its length and wider basally than in *atrifrons*, but is relatively narrower near





**Plate 1.** Taxa of the Black-crowned White-eye *Zosterops atrifrons* group (s.l.); all are adults unless otherwise noted. Clockwise from upper left: Sangihe White-eye *Zosterops nehrkorni*; Black-crowned White-eye *Z. a. atrifrons*, with the head of an immature *Z. a. atrifrons* to the right; *Z. a. surda*; Seram White-eye *Z. stalker*; Black-fronted White-eye *Z. minor delicatula*; *Z. m. minor*; *Z. m. chrysolaema*; *Z. a. sulaensis*; and the head of an apparently undescribed taxon from near Lake Matano, south-central Sulawesi. Painting by J. C. Anderton.

the tip (noticeably so when viewed from above). Other characters in which the specimen of *nehrkorni* is notably larger than the nominate race are wing length, tail length and width of the central rectrices, but its legs and feet are only slightly larger (Table 1).

The bill of the *nehrkorni* specimen is pale pinkish with a narrow brownish culmen ridge (Plate 1, Table 2); in contrast, the bill of all *atrifrons*, including juveniles, is entirely jet black. The interramal skin (the bare skin between the basal branches of the lower mandible) is

pale in *nehrkorni* (concolorous with the lower mandible), unlike adult and immature *atrifrons*, which have dusky interramal skin. On its crown, *nehrkorni* has black extending only to the mid-eye, where it ends quite abruptly, thus contrasting strongly with the bright golden-olive rear crown; conversely, on adult *atrifrons*, the black of the crown usually extends to well behind the eye but the rear edge is much less definite and contrasts little with the dull dusky-olive hind-crown. The white eye-ring of *nehrkorni* appears to be broken both

**Table 3.** Soft-part colours and altitudes from specimen labels (translations by PCR) of members of the Wallacean races of the *Zosterops atrifrons* (s.l.) complex, with their age classes.

Taxon	Bill	Iris	Feet	Age	Alt. (m)
<i>nehrkorni</i>					
	above dark brown lower light brown <sup>1</sup>	red-brown	light brown <sup>1</sup>	ad.	—
<i>atrifrons</i>					
	—	brown	grey	ad.	800
	black	light brown	blue-grey (x2)	ad., imm.	—
	black	brown	light grey	ad.	—
	black	brown	light horn (x5)	ad.	400, 450, 700
	—	—	—	ad.	1220
	black	brown	light grey	ad.	—
	black	light grey	blue-grey	ad.	—
<i>surda</i>					
	[none recorded; as <i>atrifrons</i> but base of lower mandible slightly and more extensively paler]	[none recorded]	[none recorded; as <i>atrifrons</i> in skins]	ads	—
<i>sulaensis</i>					
	black, base of mandible whitish	sepia	leaden grey	ad.	—
	black, basal half of mandible bluish-white	sepia	leaden blue	imm.	—
	black	brown	grey	ad.	1
<i>stalker</i>					
	above black, lower light blue-grey with black tip	light brown	light blue-grey	imm.?	610
	above black, lower light grey-brown	light red-brown	light grey	ad.	610
	—	light brown	light blue-grey (x2)	ad.	213
	above black, below light grey with dark tip	light red-brown	light grey	ad.	610
	above black, below light yellow-grey	red-brown	blue-grey	ad.	610
	above black, lower blue-grey with black tip	red-brown	blue-grey	ad.	610
	above black, below ?yellow-brown	red-brown	grey-blue	imm.	610
	above black, below yellowish light-grey	red-brown	blue-grey	imm.	610
	bluish	brownish-red	pale blue	ad.	762
	bluish	reddish-brown	pale blue	ad.	762
	bluish	brown	light purple	ad.	762
	bluish	brown	pale blue	ad.	762

Soft part colour data not available from any specimen of *subatrifrons*.

<sup>1</sup> Not directly comparable with observations of living birds, in which these colours appeared much brighter (see text); also does not closely match present state of specimen.



in the front and the rear (the latter feature is not quite certain), and is narrower on the lower edge than in adult *atrifrons*. The auriculars and sides of the face are uniform golden-olive in *nehrkorni*, brighter than in *atrifrons*. The throat, chin, and upper breast of *nehrkorni* are clear lemon-yellow, lacking olive or grey tones, the throat being clearly demarcated from the olive sides of the face by a dark, almost blackish moustachial streak; this feature is lacking in *atrifrons*, in which the sides of the face and the throat lack contrast.

The entire upperparts of *nehrkorni* are noticeably paler and yellower than those of *atrifrons*, although in bright sunlight this difference is less marked. In more diffused light, the upperparts look especially bright on the lower back, rump, and uppertail-coverts. The feathers of the lower upperparts are exceptionally full and fluffy in comparison with other taxa; this is evidently not an artefact of preparation style. The sides of *nehrkorni* are more extensively and definitely grey than in *atrifrons*, with only the axillaries whitish, and the grey patches on the sides of its breast are larger and darker. The edges of the outer webs of the primaries and secondaries of *nehrkorni* are broader and a brighter golden-olive than in *atrifrons*, and these extend nearer the black tips of the primaries, with which they contrast more strikingly; its tertials are uniform golden-olive. The uppertail-coverts are brighter and contrast more strongly with the blackish upper surface of the rectrices, although the uppertail is marginally if at all blacker than in adult *atrifrons*. The undertail surface of *nehrkorni* is blackish, compared with a paler, more silvery-grey in *atrifrons*. The yellow of the undertail-coverts of *nehrkorni* is slightly brighter, and also more extensive, including the lowest abdomen and thighs, which are greyish to pale yellow in *atrifrons*. The legs, toes, and claws of the specimen of *nehrkorni* are uniformly pale pinkish, without any dusky tips or shadings, even on the claws, as compared to entirely grey in *atrifrons*, lacking any flesh tones.

The wing formula of the single *nehrkorni* specimen appears to differ from that of *atrifrons*, as well as all other taxa treated herein, in having a distinctly shorter P2 and P3 (Table 1). While no sign of moult was detected in these feathers, this apparent difference is taken as tentative in the absence of further specimen material.

**Indirect comparisons between *nehrkorni* and other Wallacean taxa:** The central Sulawesi race *Z. atrifrons surda* (Plate 1) is more similar to *nehrkorni* in size than is the nominate, especially in bill and tail length (Table 1). The eye-ring of *surda* is narrow, rather like that of *nehrkorni* (Tables 1, 2). However, in most other respects *surda* differs from *nehrkorni* as does the nominate, except that *surda* is even duller than the latter, with an even more olive throat and vent; duskier upperparts; dingier, greyer underparts; and slightly browner tail, increasing its overall dissimilarity to *nehrkorni* (Table 2).

The insular populations *sulaensis* and *subatrifrons* (Plate 1) are quite different from *nehrkorni* (Tables 1, 2, 3). The former two taxa both differ from *nehrkorni* in having the eye-rings noticeably broader; the bills slightly shorter and rather heavy-looking but narrow when viewed from above, and jet-black except for the much paler base of the lower mandible; the crown much more extensively black; the throat richer and more orange-

yellow; little or no grey on the underparts; the auriculars, upperparts, and rump darker; the wings shorter, with narrower, duller margins to the remiges; the vent with duller and less extensive yellow; and the rectrices duller and less black, with olive edges (the latter at least on *sulaensis*).

The taxon *stalker*i (Plate 1) from Seram is the form of *Zosterops atrifrons* (s.l.) that is most different from *nehrkorni*, with its overall very dull, dark coloration. It does, however, have the bill and claws (at least in skins; Tables 2, 3) somewhat paler than in the other taxa, but with a much different pattern and not nearly as pale and bright as in *nehrkorni*.

Thus, all other forms of *Zosterops atrifrons* (s.l.) differ more in colour from *nehrkorni* than does the nominate race. Living *nehrkorni* seen by FRL in 1996 (see below) showed bright orange-pink bare parts and a noticeably black forehead. Those seen by JCW in 1996 showed conspicuously pale orange-flesh, bright coloration of the bill and legs, and relatively bright overall plumage, consistent with that of the holotype. In comparison, all of the many individuals of the nominate race seen by JCW in North Sulawesi showed black bills and grey legs, regardless of age (Wardill and Hunowu 1998), as do all specimens.

## Descriptions of other taxa of *Zosterops atrifrons* (s.l.)

**Morphology of *stalker*i:** Direct comparisons were made between *stalker*i and all other taxa of *Zosterops atrifrons* (s.l.) except *nehrkorni*. Compared to all the above, the bill of *stalker*i is paler, deeper- and broader-based, heavier, straighter, and blunter-tipped. Study skins of *stalker*i uniformly assume a peculiar colour pattern to the bill that differs somewhat from soft-part colour notes on the labels (Tables 2, 3), but as it is quite consistent among the specimens it bears noting: the bill looks mostly dark horn, with a distinctly paler tip; both cutting edges and the rami of the lower mandible are also pale horn. The eye-ring is rather narrow, complete in the rear, and incomplete in the front. The entire crown and sides of the head are black, through the submalar and a small amount on the chin; all the black areas grade into the dark olive nape, sides of neck, and throat. The upperparts are darker and bronzier than in any other taxon, and the rump is a distinctive yellow-bronze. The marginal coverts are black, unlike any other form of *atrifrons* (s.l.; but like the Ambon White-eye *Z. kuehni*); the wing edgings are narrow and light olive, and the tertials are dark bronze-olive. The sides of the breast are greyish-white, as are the flanks; the undertail-coverts are orange-yellow, the thighs are whitish, and the uppertail is brownish-black. The feet are dark, with paler claws. Immature *stalker*i, of which specimens have been examined both at NNM and AMNH, are very like the adults but they have the throat even greener and more diffuse, with more blackish mixed into the chin feathers, and the sides of the face and rear crown are more olive and less blackish.

**Morphology of *sulaensis*:** Comparisons of *sulaensis* with nominate *atrifrons* were made at NNM (4 definite, 1 without locality, identified as *sulaensis* by Mees [1961])



and confirmed by PCR, and five at AMNH). The bill of *sulaensis* (Plate 1, Tables 2, 3) is black and shaped as in *atrifrons*, but is larger and has an extensively pale base; the eye-ring is extremely broad; the throat is a more clear-cut and brighter yellow, and is very strongly demarcated from the dark moustache and dark olive sides of the head. The upperparts are slightly darker than in *atrifrons*; the sides of the breast are only very slightly tinged grey and the sides not at all; and the thighs are white or lemon yellow. The marginal wing-coverts are yellow; the edgings of the primaries and secondaries are narrow and olive; and the tertials are dull dark olive. The uppertail-coverts are drab, and contrast little with the tail; the undertail-coverts are dull yellow; and the rectrices are not as black, with olive edgings. The claws and feet are dusky. An immature *sulaensis* (at AMNH) has a noticeably smaller white eye-ring than do adults, to which it is otherwise quite similar.

**Distinctness of *subatrifrons*:** Comparisons of *subatrifrons* (two adults and two immatures) were made at AMNH with four adult and one immature *sulaensis*. One of the adult *subatrifrons* (AMNH 700371) has a very bright throat and a large eye-ring, and is almost indistinguishable from *sulaensis*, while the other adult *subatrifrons* (AMNH 700372) has a more olive throat. Compared to *sulaensis*, *subatrifrons* differs in being slightly smaller, with a smaller eye-ring and somewhat more grey on the breast. These two island taxa share the extensive pale base to the bill; the broad to very broad eye-ring; the sharp contrast between the dusky sides of head and throat, and between throat and breast; and perhaps the olive edgings to the tail. Immature *subatrifrons* are duller (and more like the nominate) than the same stage of *sulaensis*.

**Morphology of population from Lake Matano area, Sulawesi:** An almost certainly undescribed race of *Zosterops atrifrons* from the Lake Matano area, near the base of the south-eastern peninsula of Sulawesi (Fig. 1, Plate 1) has yet to be collected, but a photograph has been published of a hand-held bird (Wood and Holmes 1981, Holmes and Holmes 1985). From the published descriptions and photograph, this population evidently has a rather heavy black bill with a small paler area at the base of the lower mandible; a dark reddish-brown iris; an eye-ring of moderate width (slightly broader above); the black of the crown ending at about the rear eye; golden-olive auriculars; strong contrast between the blackish malar and the brilliant golden-yellow throat; a very bright yellow rump; white underparts; bright yellow undertail-coverts; greenish edges to the rectrices; and dark grey legs through claws. Thus it differs distinctly from *surda* in many ways (Fig. 1, Tables 1-3), despite their geographical proximity. The Lake Matano population evidently resembles *subatrifrons* quite closely, more so than any other taxon, but specimens are required before it can be formally described.

### Vocalizations

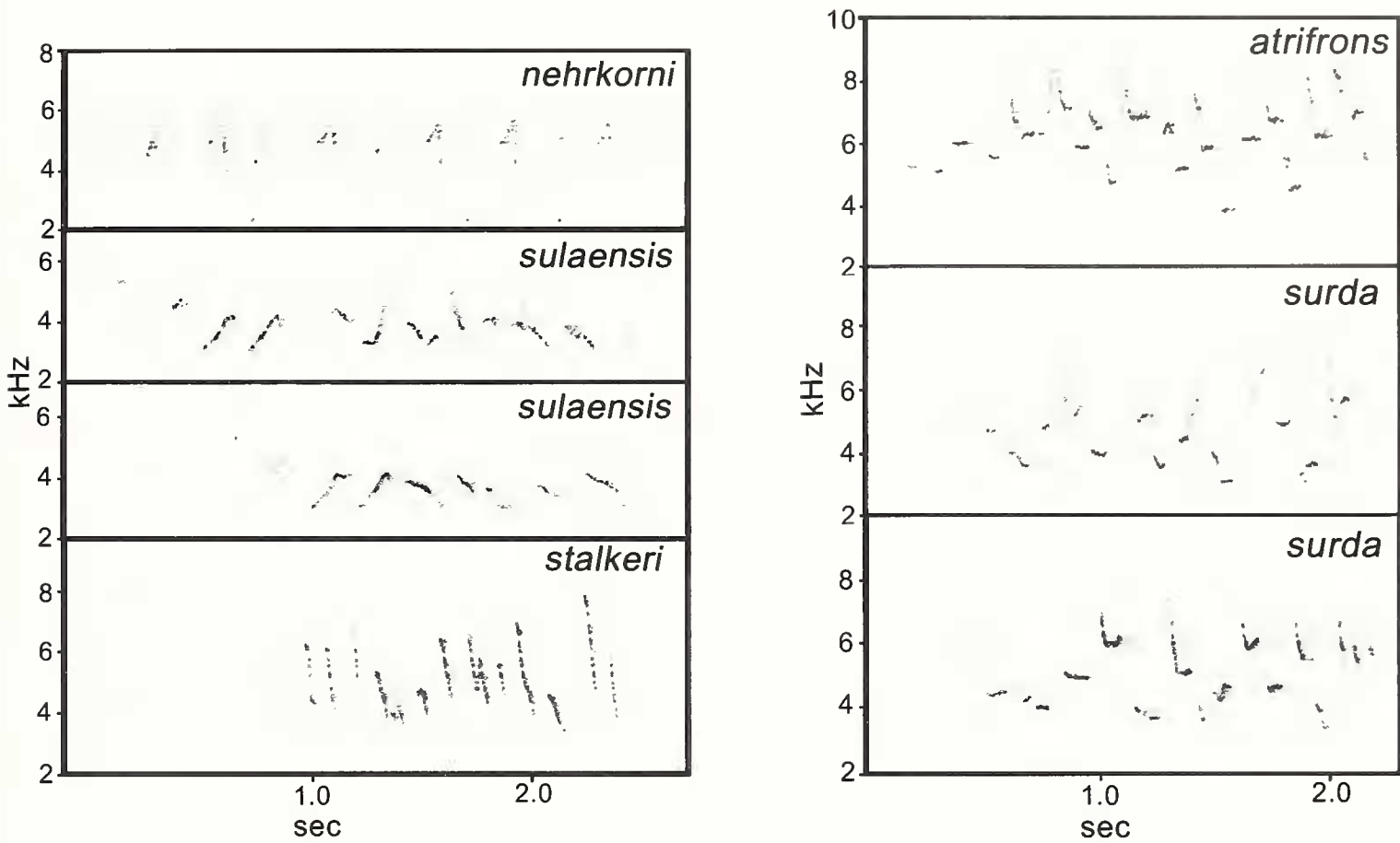
The primary songs of *Zosterops a. atrifrons* and *Z. a. surda* are fairly similar (Fig. 2). The song of both is a clear, sweet warble preceded by two or three audible thin notes of relatively uniform frequency, lasting about 0.5 sec.

The warble is comprised of clear, sweet, loud, rapid notes with a great frequency range (*c.* 6-8.5 kHz), alternating with very short (*c.* 0.1 sec), much lower frequency (*c.* 4-5 kHz) notes. There are four or five warbling elements per sec, and the warbling portion of the song lasts *c.* 2 sec. While the elements of the warbling segment are not uniform, they do not vary much in frequency, nor do they abruptly switch form. The song of *Z. a. surda* has been described elsewhere as "a loud and characteristic double note followed by a rapid tinkling twitter, descending and trailing off" (Watling 1983: 259).

A tape-recording of *nehrkorni* was made by JR on Sangihe on 17 February 1999 (see below for details) and, although he did not see the vocalizing bird, the song is very similar to that taped by FRL, and furthermore is similar in most respects to those of *atrifrons* and *surda* (Fig. 2). On 16 and 18 February 1996 he and J. Mole had also heard but not tape-recorded a similar song in the same area. JR considers that *nehrkorni* lacks the double grace note that *atrifrons* gives before the main song strophe, but this could not be confirmed from the sonagrams, which were not suitable for reproduction due to the distance of the singing bird and the quantity of competing noise. A sonagram of the first half of the song in JR's tape closely matches the sonagram of *nehrkorni* in Fig. 2 (recording by FRL) in frequency (*c.* 4.8-5.2 kHz), shape and uniformity of notes, and note spacing. However the portion of the song between 1.3-1.5 sec from the beginning descends to *c.* 3.5 kHz, and there are very high, weak strophes that evidently reach 7.5 kHz, similar to those in *atrifrons*. It is unclear whether FRL's recording is of song or call notes, but the former seems more likely as it is such a close match for that of JR. If a song, FRL's recording must either be of a variant song, or the weaker higher and lower frequency portions were cut off in sonagram production. Based on JR's tape, the song of *nehrkorni* evidently (to PCR) sounds thinner, more tinkling, and less warbling than for *surda* (and hence probably *atrifrons*), and the terminal portion descends more noticeably. The sonagrams from this recording indicate that the song of *nehrkorni* differs additionally from that of *atrifrons* in having the lower notes in the first part of the song of a more constant frequency, and they clearly show the strong descent of the terminal portion. Much better quality and more comprehensive recordings will be needed for confirmation of these apparent differences in vocalizations, however.

The primary song of *sulaensis* differs strikingly from that of *atrifrons* and *surda* (Fig. 2). There is a resemblance in quality and form of the song, but that of *sulaensis* is more strident, robust, and less sweet, with more staccato notes that have almost a bouncing-ball quality. The entire song is at a lower frequency, and the frequency range is much reduced, compared to *atrifrons* and *surda*, and hence the effect is much less warbling. There are about four notes per second, the song is somewhat variable in length but lasts around 2 sec, and there are no separate short lower notes as for *atrifrons* and *surda*. After the introductory notes (not evident on the sonagram) much like those of the above taxa, the main part of the song begins at its highest frequencies, then trending to lower frequencies, and abruptly changing direction after about 1 sec, both in frequency and in note shape. The end of the song is somewhat higher than the middle, giving a





**Figure 2.** Sonograms of presumed primary songs of the *Zosterops atrifrons* (s.l.) group: *Z. a. atrifrons* (tape-recording by JR, 16 September 1998, Lokon, Tomohon, 1°19'N 124°49'E, north-eastern Sulawesi; sonograms of several other cuts made the same day are virtually identical); *Z. a. surda* (upper cut by S. Smith, NSA#45860, 24 July 1991, 1,000 m, Dongi Dongi, Lore Lindu, central Sulawesi; lower cut by A. Greensmith, NSA#32916, 18 January 1991, Karamora, Lore Lindu); *Z. nehrkorini* (tape-recording of very poor quality made by FRL [see text], made on 8 August 1996, 900 m, Gng. Sahengbalira, Sangihe); *Z. a. sulaensis* (two cuts from tape-recording by R. Lucking, 22 October 1991, Pulau Seho, 2°00'S 124°20'E, Taliabu, Sula Islands); and *Z. stalker* (tape-recording by I. Isherwood, 17 August 1996, Wae Fufa, 3°02'S 130°25'E, north-eastern Seram).

questioning effect to the last half. The song is more structured, with a more discernible pattern than for the above three taxa.

The song of *stalker* is evidently remarkably different from all the above (Fig. 2). We have not heard this song, but the sonagram shows that it consists of very rapid, fairly uniform elements (c. 9 per sec), most with a great frequency range (as much as 4 kHz per note).

Contact calls of *nehorkorini* seem to be thinner and higher-pitched than for the nominate race (JCW in Riley 1997a), but these were not tape-recorded. A sight record of *nehorkorini* by I. Hunowu (see below) was accompanied by the following notes on vocalizations: “Call – three notes recalling [*Dicaeum*] *aureolimbatus* but higher pitched and sharper –*swiit*.....*swiit*....*swiit*, about 2 seconds duration” (Action Sampiri log).

**Sight and aural reports of *nehorkorini***

In the past few years, there have been only three sight reports of *Zosterops nehrkorini* with corroborating details, as well as one now-retracted sight report and three auditory-only reports; these are the only records since the collection of the type specimen. As some confusion has been introduced into the literature, we attempt to clarify matters here. Chronologically, the reports are:

[2 September 1995: Observer J. O. H. Small; a few hours spent alone on one afternoon in the Gng. Sahendaruman

forest. Two birds viewed briefly in a mixed feeding flock were tentatively identified by the observer as *Zosterops nehrkorini* and published as such in Riley (1997a, b), but Small has since withdrawn this record (J. O. H. Small *in litt.* to JR, March 2000).]

7 and 8 August 1996: Observer FRL; three *Z. nehrkorini* together, calling and moving slowly through dense subcanopy about 8 m above the ground, at c. 900-920 m near the top of the Gng. Sahendaruman-Sahengbalira ridge (Fig. 1). FRL followed the three birds for about ten minutes on 7 August; they were feeding in close proximity to each other in the subcanopy and canopy of the low stature forest at the top of the caldera ridge. He saw them again at the same spot on 8 August, but only very briefly. Tape-recordings made of the birds calling to each other during this period (Fig. 2) are of poor quality due to background noise of wind and insects. The white-eyes were seen intermittently and very well on a number of occasions. They hardly moved for some time and then flew off a short distance and were lost to sight.

10 November 1996: Observers JCW, I. Hunowu, and J. Ekstrom; three *nehorkorini* were clearly seen by JCW for about 2 min and found to be very distinct from the nominate race; in submontane forest on the Gng. Sahengbalira ridge at c. 900 m, at the same site as the sighting by FRL in August (Riley 1997a, Wardill and

Hunowu 1998). In two weeks spent on this mountain, only this single record was made (Wardill and Hunowu 1998).

29 November 1998: Observer I. Hunowu; a single bird observed for a short time hanging upside down in a tree top gleaning for insects on leaves; in primary forest at *c.* 840 m at Tukade Batu in the Gng. Sahendaruman Forest. Notes written shortly thereafter accord with *nehrkorni* except that the observer did not note bare part coloration.

16 February 1999: Observers JR and J. Mole; a white-eye song, presumed to be that of *nehrkorni* (and confirmed as such by analysis of sonagram), was heard in primary hill forest at *c.* 840 m in the Gng. Sahendaruman Forest below the peak of Gng. Batu Kakiraeng, above the village of Malamenggu, Tabukan Selatan sub-district.

17 February 1999: Observers JR and J. Mole; tape-recording made of a single bird singing the same song as was heard the previous day from the top of a tall tree some 100 m distant from the previous day's aural record.

18 February 1999: Observers JR, I. Hunowu, Y. Hunowu, and J. Mole; same song heard as on previous days, at an adjacent point-count location approximately 500 m distant from the 16 February record. The bird was singing from the top of a tall tree in primary hill forest at *c.* 750 m. The singing birds were not observed on any of these dates.

No other records of *nehrkorni* have been made during the total of 60 field days spent in the Gng. Sahendaruman forest by JCW and JR between August 1998 and February 1999. Further visits to the area, totalling 10 field days, including one full day in October 1999 by JCW and four days in December by FRL and JCW, as well as recent visits by other observers (F. G. Rozendaal, I. Mauro, B. F. King, and F. Verbelen), have failed to produce any further records of *nehrkorni*.

## DISCUSSION

### Specific status of *Zosterops stalker*

The Seram form, *stalker*, as already remarked by White and Bruce (1986), is the most distinctive form of *Z. atrifrons* (s.l.). This great degree of difference is not evident from the original description, which merely states: "Most nearly allied to *Z. atrifrons*, Wallace, from Celebes, but the black on the forehead is continued over the crown to the occiput and sides of the head" (Ogilvie-Grant 1910: 96). Not only does *stalker* differ obviously in its very extensive black crown and dull greenish coloration, but it is also the only putative member of the group with black marginal wing-coverts. Its bill is also a different shape, being straighter and more peg-like, and at least in dried specimens the bill assumes a different colour pattern than in the other taxa. It is the only species with noticeably bronzy overall coloration, and its orange-yellow undertail-coverts are the only bright plumage areas. Its song, both as shown in the sonagram, and as described by Coates and Bishop (1997), differs strikingly from all the other taxa. We

therefore consider that a sister-species relationship of *stalker* with any member of *Zosterops atrifrons* is uncertain, and that the former must be treated as specifically distinct. Stresemann (1931), despite his revolutionary lumping of many other taxa, followed previous authors in maintaining *stalker* as distinct. Van Bemmelen (1948) was evidently the first to place it within *atrifrons*, although without enumerating his reasons for doing so, and he was followed in this by Mees (1961). We suggest the common name "Seram White-eye" for *Zosterops stalker* Ogilvie-Grant, 1910.

Although *stalker* and *Z. kuehni* (the latter of neighbouring Ambon) differ in several characters, both share black marginal coverts, a character not shown by other putative members of the *atrifrons* (s.l.) group. While *stalker* and *kuehni* should clearly not be considered conspecific, the principal reason given by Mees (1961) for their non-conspecificity is the supposed presence of the latter on Seram. Nevertheless, the circumstances of the collection of the single specimen of *Zosterops kuehni* (otherwise endemic to Ambon), which is in the NNM, are far from clear, and no confidence can be granted its provenance. The specimen is labelled as being from Wahai, on the north coast of Seram (on the opposite side of the island from Ambon), and collected by Moens in 1862, and it was included in a shipment Moens sent from Wahai (R. W. R. J. Dekker *in litt.*), but archival material showed that B. Moens was not the actual collector, and was only acting as an intermediary for the real collector, Dr. E. Benjamins (Mees 1969: 286). The specimen bears no original label, but if it had ever had one, O. Finsch would have discarded it after recopying it around 1900, as was unfortunately his standard curatorial practice. However, this provenance was evidently not a recopying error made by Finsch, as the specimen had obviously been labelled as from Seram some 20 years earlier – Salvadori (1881) listed it (prior to the description of *kuehni*) under *Z. novaeguineae* (as did Finsch 1901); even then Salvadori was of the opinion that the locality must be in error. Given that several older skins, at least of white-eyes and scops owls *Otus*, in the Leiden collection are almost certainly mislabelled as to locality (Mees 1953, Rasmussen and Prys-Jones MS), this lone specimen with the attendant possibilities for confusion should not be considered proof of the occurrence of *kuehni* outside Ambon, or its sympatry on Seram with *stalker*.

### Specific status of *Zosterops nehrkorni*

The white-eye of Sangihe is apparently restricted to montane forest, unlike the taxa on Sulawesi (Wardill and Hunowu 1998). The very few records of *nehrkorni*, despite intensive field work and the recent presence of numerous visiting birders who have specifically searched for it, have amply demonstrated its rarity. Presumably it has been rare since the 19th century, as only one specimen was ever collected. Fortunately, this specimen is a full adult in excellent preservation and plumage condition, which facilitates comparisons.

While the morphology of *nehrkorni* confirms its relationships with *Zosterops atrifrons*, it is quite distinct in a number of characters. The numerous distinctions include conspicuous colour differences in bill and legs that seem likely to be a species recognition character; the taxon is apparently restricted to pristine habitats at



higher elevations, and its song evidently differs in minor ways as well. Thus, this form has evolved in isolation into a taxon best treated at the specific level. We propose the common name "Sangihe White-eye" for *Zosterops nehrkorni* Blasius, 1888.

Immediate listing of *Zosterops nehrkorni* at some higher level of threat is clearly warranted. Based on IUCN Red List Criteria for assessing threat categories, we believe that the species is Critically Endangered, in which category it is expected to be treated in the forthcoming Red Data Book for Asia (N. J. Collar *in litt.*).

### Taxonomic status of *subatrifrons* and *sulaensis*

The taxon *subatrifrons*, from Peleng Island in the Banggai Islands (Fig. 1), has been variously treated as a synonym of the nominate race (Finsch 1901, Mayr 1967, White and Bruce 1986), or as possibly not differing from *sulaensis* of the neighbouring Sula Islands (Mees 1961). Part of the confusion appears to stem from the fact that the sole *subatrifrons* specimen in the BMNH is an immature that looks very like many specimens of the nominate race.

Adult specimens of *subatrifrons* (e.g. those at the AMNH) are, however, much closer in appearance to *sulaensis*, and although in some respects *subatrifrons* seems intermediate between the nominate and *sulaensis*, it is clearly much closer to the latter. Indeed, for a time the two were considered synonymous, prior to the erroneous synonymy of *subatrifrons* with the nominate race, which was presumably prompted by the immature BMNH specimen. Hartert (1898), although he had access to the AMNH series of *sulaensis*, did not describe it as new, very likely because of the single immature in that series with its narrower eye-ring than in the adult. In the original description of *sulaensis*, which was apparently based on a single female compared with five female *subatrifrons* in Dresden, *sulaensis* was said to have the yellow throat "finer and darker", and to be "perhaps also slightly larger" (Neumann 1939). We add this information as these specimens are presumably still in Dresden and not among those we have had available for study, and it reinforces our own observations. In any case, it is clear that *subatrifrons* and *sulaensis* are closely related, and this resolves an apparent biogeographic anomaly in White and Bruce (1986), who treated *subatrifrons* as synonymous with the nominate race of the Minahasa Peninsula, rather than the geographically nearer *surda* of central Sulawesi.

Were it not for the somewhat intermediate aspect of *subatrifrons*, the distinctiveness of *sulaensis* both in morphology and in vocalizations as compared to the nominate is such that we would have unhesitatingly recommended specific status herein. However, if *sulaensis* were treated as specifically distinct, on morphology *subatrifrons* must belong to the same species, and it is the name with priority. As we have no information on the vocalizations of *subatrifrons*, we are therefore presently unable to resolve this matter. Additionally, the existence of an undescribed form very similar to *subatrifrons* in the Lake Matano area of Sulawesi (Holmes and Holmes 1985) provides a further complication. This form differs so much from *surda* that, in the event of a split, the division would presumably be

between the *atrifrons/surda* group and the *sulaensis/subatrifrons*/undescribed subspecies group. Much more information is therefore needed on vocalizations of the latter two, and on the behaviour and morphology of *surda* and the undescribed form in contact zones, if any.

### Geographic variation within Sulawesi

The race *Zosterops atrifrons surda* from north-central Sulawesi was described by Riley (1919) from a good series, most at the USNM (Riley 1924, Stresemann 1936b, Deignan 1961), but it was not recognized by White and Bruce (1986), evidently because of their assumption that *subatrifrons* was a synonym of nominate *atrifrons*. Nevertheless, although the differences are relatively subtle, *surda* is quite distinct in size and coloration from the nominate; as Riley (1919) stated originally, "These two series when compared are strikingly different to the eye though hard to discriminate in words." Given the presumed lack of gene flow with the nominate race isolated on the Minahasa Peninsula, the differences are unlikely to be clinal in nature, and no suggestion of this is apparent from the specimen material. Indeed, two USNM specimens from Tolitoli (near the north-western base of the Minahasa Peninsula) are definitely of the nominate race despite their geographic proximity to *surda*, to which they show no approach. Although almost certainly closely related to the nominate race, *surda* clearly requires recognition at the subspecific level.

The recent documentation of white-eyes of distinctive morphology in the northern part of the south-eastern peninsula of Sulawesi (Holmes and Holmes 1985) shows that there is at least local sympatry of the *atrifrons* group with the Pale-bellied White-eye *Z. consobrinorum*, although farther south-east in Sulawesi there have been no reports of members of the *atrifrons* (s.l.) group, even in recent surveys (Wardill *et al.* 1999). The unnamed taxon from Lake Matano has a long tail as in *surda* but is otherwise quite different, especially in its very bright coloration and short wings. This degree of differentiation is surprising since the nearest known population attributed to *surda* (but the basis for this attribution may need to be re-evaluated) is only about 100 km to the north, at Lake Poso (Holmes and Holmes 1985). This apparently new taxon, although it is common in highly disturbed areas as well as forest (Holmes and Holmes 1985), was entirely overlooked until rather recently, pointing up the inadequate state of ornithological knowledge there. Incidentally, because Holmes and Holmes (1985) conditionally proposed a name for the Lake Matano population (a practice discouraged by the ICZN), that name is not available and has no nomenclatural status (ICZN 1985: 395).

### Specific status of the New Guinean group

The taxa of *Zosterops atrifrons* (s.l.) from the Papuan region are extremely heterogeneous. However, they are united by three characters that are rare or lacking in the Wallacean taxa: 1) their wing formula, in which the wing-point is formed by P2 and/or P3, and the inner primaries are shorter; the wing is essentially narrower and more pointed than in the *atrifrons* group (but strangely, this pattern is apparently shared with the inadequate sample of *subatrifrons*); 2) the presence of a dark olive patch on



the outer thigh (vs pale greyish, yellowish, or whitish in the *atrifrons* group); and 3) their (usually) more curved bill tips. Thus it seems evident that the similarities that led Mees (1961) to unite the New Guinean and Wallacean groups, those between the south-east New Guinea race *delicatula* and the Sula Islands race *sulaensis*, are not due to close relationship. Instead of being “virtually indistinguishable” (Mees 1961: 64), *delicatula* and *sulaensis* differ in all the above group characters, as well as in the blacker auriculars and bill-base of *delicatula* (Table 2). The statement that their “bright throats, wide eye-rings, and black foreheads are of a fairly specialized type” does not accord with the mosaic occurrence of all these characters (especially the former two) through much of the range of the genus *Zosterops*, as far away as Africa.

The taxon from the northern watershed of New Guinea, *Z. atrifrons minor* Meyer, 1874 (s.l.; Plate 1), seems highly distinct, lacking all but the merest suggestion of an eye-ring, as well as any trace of a black forehead or even black lores; in addition it is very brightly coloured above. This form would probably not be considered conspecific with either *Zosterops atrifrons* (s.l.) or the *chrysolaema* group restricted to New Guinea, were it not for the existence of a specimen with a fairly well-developed eye-ring from an area adjacent to that occupied by a quite different race, *chrysolaema* (Fig. 1). This specimen was the sole basis for the supposed race ‘*rothschildi*’, which was said to be intermediate between *minor* and *chrysolaema* by its describers, Stresemann and Paludan (in Stresemann *et al.* 1934). Nevertheless, PCR could see no other differences besides the larger eye-ring between the unique type of ‘*rothschildi*’ and typical *minor*, nor were any others mentioned by Stresemann and Paludan. However, at least one specimen from the Adelbert Mountains of New Guinea has also been said to be indistinguishable from ‘*rothschildi*’ (Mees 1969). As this area is at the opposite end of the range of *minor* from the type locality of ‘*rothschildi*’ and also where overlap with *chrysolaema* could occur, we agree with Mees’s (1969) conclusion that ‘*rothschildi*’ must be a hybrid or intergrade, and not worthy of a name. Further study is needed to determine the frequency of this apparent hybridization, and whether *minor* should continue to be treated as conspecific with the *chrysolaema* group; these quite dissimilar taxa are largely or entirely separated by the central mountain range (Mees 1969) and thus contact may be limited. The English name used by Sibley and Monroe (1990) for this group was Black-fronted White-eye.

The remaining currently recognized races of *Zosterops atrifrons* (s.l.; Plate 1) are *chrysolaema* Salvadori, 1875, in most of western and southern New Guinea; *gregaria* Mayr, 1933, from the Huon Peninsula, and *delicatula* Sharpe, 1882, of south-eastern New Guinea. These are all characterized by well-developed white eye-rings, fairly dark upperparts, and black foreheads, and clearly seem to be a natural group. Thus we follow Sibley and Monroe (1990) in treating the New Guinea forms as a separate species, for the present at least as races of *Zosterops minor*, although further work may well establish that this is better treated as more than one species.

## History of the type specimen of *nehrkorni*

No documentation has been found on the precise collection locality of the Platens’s unique specimen of *Zosterops nehrkorni*. The coastal town of Manganitu (3°35'N, 125°31'E) has been given as the type-locality (Hinckelmann and Heinze 1990), but this was the Platens’s base of operations on Sangihe during December 1886 through at least February 1887 (Blasius 1888b). In an article written in Manganitu in January 1887 (the month after the collection of *Z. nehrkorni*), Dr Platen remarked on the considerable difficulty he had experienced in finding local assistants who were both skilled in shooting birds and willing to take time away from fishing (Platen 1887). He also described the area around Manganitu even then as a broad strip of country covered by coconut plantations, with hills rising so steeply behind it that, during the monsoon, one falls back two steps for every three taken (Platen 1887). The original label only states “Gross-Sangir”, and in a report on the collection, the type locality of *nehrkorni* was given as “bei” (= near) Manganitu (Blasius 1888c). As it is most unlikely that the white-eye would have been taken in a coconut plantation, we can only presume that it was collected somewhere on the slopes of Gng. Sahendaruman, very likely near Manganitu. Presently, the forest of Gng. Sahendaruman extends in places as low as 450 m, but the white-eye has not been recorded below 750 m.

Many of the Platens’s skins were taken by native hunters, but the soft-part colours of *nehrkorni*, including that of the iris, were recorded in German on the label in writing similar to that of Platen labels from Sulawesi. This indicates that one or both of the Platens must have seen the *nehrkorni* specimen before it was skinned, or they would not have been able to record its iris colour. The fact that they recorded its bill and foot colours as “hellbraun” (light [or perhaps bright] brown) seems likely to reflect a different interpretation of colours to our present understanding, given that the specimen was later painted with these soft parts paler and pinker than light brown (Meyer and Wigglesworth 1898: pl. 31), and that it presently has them much paler and brighter than in specimens of the nominate race also collected by the Platens, and presumably subject to similar post-mortem conditions. The earliest figure of *Zosterops nehrkorni* (Blasius 1888b: Fig. 2), however, shows it with a fairly dark bill but pale legs, but this plate is rather crude and inaccurate in other respects as well.

It remains unclear why the Sangihe White-eye is so rare, even within the small remaining area of submontane forest on the caldera of Sangihe. If it had ever occurred in low-elevation forest, one would expect it to have been found near the lower limit of presently existing forest. It is not a matter of being difficult to see, as it is not restricted to the canopy of tall trees, and indeed the forest at the higher elevations in which it occurs is of fairly low stature. Further work is urgently needed to better understand the factors controlling its populations, and to establish its numbers and full distribution.



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## REFERENCES

- van Bemmelen, A. C. V. (1948) A faunal list of the birds of the Moluccan islands. *Treubia* 19: 323–402.
- Blasius, W. (1888a) Verein für Naturwissenschaft. 7. Sitzung am 5. Januar 1888. *Braunschweigische Anzeigen* 11 January 1888(9): 85–86.
- Blasius, W. (1888b) Die Vögel von Gross-Sanghir (mit besonderer Berücksichtigung der in den Jahren 1886 und 1887 von Herrn Dr. Platen und dessen Gemahlin bei Manganitu auf Gross-Sanghir ausgeführten ornitholog. Forschungen) nebst einem Anhang über die Vögel von Siao. *Ornis* 4: 527–646.
- Blasius, W. (1888c) [Report from Braunschweig.] *Isis, Zeitschr. naturw. Lieb.* 13 (10): 78.
- Coates, B. J. and Bishop, K. D. (1997) *A guide to the birds of Wallacea*. Alderley, Queensland: Dove.
- Deignan, H. C. (1961) Type specimens of birds in the United States National Museum. *Bull. U. S. Nat. Mus.* No. 221.
- Dickinson, E. C. and Heucke, J. (1986) Notes on Philippine birds 8. A collection from Mindoro revisited. *Bull. Brit. Orn. Club* 106: 56–63.
- Finsch, O. (1901) Zosteropidae. *Das Tierreich* 15.
- Hartert, E. (1898) List of a collection of birds made in the Sula Islands by William Doherty. *Nov. Zool.* 5: 125–136.
- Hinckelmann, C. and Heinze, G.-M. (1990) Typusexemplare der von Wilhelm Blasius beschriebenen Vögel. *Braunschw. naturkd. Schr.* 3(3): 609–628.
- Holmes, P. R. and Holmes, H. J. (1985) Notes on *Zosterops* spp. from the Lake Matano area of southeast Sulawesi, Indonesia. *Bull. Brit. Orn. Club* 105: 136–139.
- Howard, R. and Moore, A. (1991) *A complete checklist of the birds of the world*. Second edition. London: Academic Press.
- ICZN. (1985) *International Code of Zoological Nomenclature*. Third edition. London: International Trust for Zoological Nomenclature.
- Lambert, F. R. and Rasmussen, P. C. (1998) A new scops owl from Sangihe Island, Indonesia. *Bull. Brit. Orn. Club* 118: 204–217.
- Mayr, E. (1965) Relationships among Indo-Australian Zosteropidae (Aves). *Breviora* 228: 1–6.
- Mayr, E. (1967) Family Zosteropidae. Pp. 289–326 in R. A. Paynter (ed.). *Check-list of birds of the world*, 12. Cambridge, Massachusetts: Museum of Comparative Zoology.
- Mees, G. F. (1953) The white-eyes of the Aroe Islands (Aves, Zosteropidae). *Zool. Med.* 32: 25–30.
- Mees, G. F. (1961) A systematic review of the Indo-Australian Zosteropidae (Part II). *Zool. Verh.* 50: 1–168.
- Mees, G. F. (1969) A systematic review of the Indo-Australian Zosteropidae (Part III). *Zool. Verh.* 102: 1–390.
- Meyer, A. B. and Wieglesworth, L. W. (1898) *The birds of Celebes and the neighbouring islands*, 2. Berlin: R. Friedländer.
- Neumann, O. (1939) Two new races from Sula Islands. *Bull. Brit. Orn. Club* 59: 156.
- Ogilvie-Grant, W. R. (1910) [Description of a new species of white-eye from Ceram.] *Bull. Brit. Orn. Club* 25: 96.
- Platen, C. C. (1887) Der Fledermauspapagei von Sangir (*Coryllis catamene*, Schleg.). *Gefied. Welt* 16(24): 263–265.
- Rasmussen, P. C. and Prys-Jones, R. P. (MS) History vs mystery: the reliability of museum specimen data.
- Riley, J. H. (1919) Six new birds from Celebes and Java. *Proc. Biol. Soc. Washington* 32: 93–96.
- Riley, J. H. (1924) A collection of birds from north and north-central Celebes. *Proc. U. S. Nat. Mus.* 64(16): 1–118.
- Riley, J. (1997a) *Biological surveys and conservation priorities on the Sangihe and Talaud islands, Indonesia*. CBS Conservation Publications: Cambridge.
- Riley, J. (1997b) The birds of Sangihe and Talaud, north Sulawesi. *Kukila* 9: 3–36.
- Salvadori, T. (1881) *Ornitologia della Papuasie e delle Molucche*. Part 2. Torino: G. B. Paravia.
- Sibley, C. G. and Monroe Jr, B. L. (1990) *Distribution and taxonomy of birds of the world*. New Haven: Yale Univ. Press.
- Stresemann, E. (1931) Die Zosteropiden der indo-australischen Region. *Mitt. Zool. Mus. Berlin* 17(2): 201–238.
- Stresemann, E. (1936a) The Formenkreis-Theory. *Auk* 53: 150–158.
- Stresemann, E. (1936b) A nominal list of the birds of Celebes. *Ibis* (13)6: 356–369.
- Stresemann, E., Paludan, K., Hartert, E. and Rothschild, W. (1934) Vorläufiges über die ornithologischen Ergebnisse der Expedition Stein 1931–32. *Orn. Monatsb.* 42: 43–46.
- Svensson, L. (1970) *Identification guide to European passerines*. First edition. Tring, U.K.: British Trust for Ornithology.
- Wardill, J. C., Fox, P. S., Hoare, D. J., Marthy, W. and Anggraini, K. (1999) Birds of the Rawa Aopa Watumohai National Park, south-east Sulawesi. *Kukila* 10: 91–114.
- Wardill, J. C. and Hunowu, I. (1998) First observations of the endemic subspecies of Black-fronted White-eye on Sangihe, North Sulawesi. *Oriental Bird Club Bull.* 27: 48–49.
- Watling, D. (1983) Ornithological notes from Sulawesi. *Emu* 83: 247–261.
- White, C. M. N. and Bruce, M. D. (1986) *The birds of Wallacea (Sulawesi, the Moluccas and Lesser Sunda Islands, Indonesia)*. London: British Ornithologists' Union (Check-list No. 7).
- Wood, H. J. and Holmes, P. R. (1981) Birdcount in Sulawesi. *GEO, Australasia's Geographical Mag.* 3: 90–109.

Pamela C. Rasmussen, Division of Birds, Smithsonian Institution, Washington, D.C. 20560-0116, and Michigan State University Museum, East Lansing, MI 48824-1045, U.S.A.

James C. Wardill, PO Box 163, Tahuna 95800, Sangihe-Talaud, Sulawesi Utara, Indonesia

Frank R. Lambert, PO Box 7087/JKP, Sarinah Jakarta 10350, Indonesia

Jon Riley, WCS—Indonesia Program, PO Box 1131, Manado, Sulawesi Utara, Indonesia